New cloud model could help with climate research

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Clouds have a number of important functions. They act as reflectors whereby water droplets in the cloud reflect radiation back to the Earth, which contributes to the greenhouse effect. Credit: University of Gothenburg

When clouds meet clear skies, cloud droplets evaporate as they mix with dry air. A new study involving researchers from the University of Gothenburg has succeeded in capturing what happens in a model.

Ultimately, this could lead to more accurate climate modeling in the future.

The clouds in the sky have a significant impact on our climate. Not only do they produce precipitation and provide shade from the sun, but they also act as large reflectors that prevent the radiation of heat from the Earth—commonly known as the greenhouse effect.

"Although clouds have been studied for a long time, they are one of the biggest sources of uncertainty in climate models," explains Bernhard Mehlig, Professor of Complex Systems at the University of Gothenburg. "This is because there are so many factors that determine how the clouds affect radiation. And the turbulence in the atmosphere means that everything is in constant motion. This makes things even more complicated."

Focusing on the cloud edge

An article in *Physical Review Letters* presents a new statistical model that describes how the number of water droplets, their sizes and the water vapor interact at the turbulent cloud edge. The distribution of water droplets is important because it affects how clouds reflect radiation.

"The model describes how the droplets shrink and grow at the cloud edge when turbulence mixes in drier air," adds Johan Fries, a former doctoral student in physics and co-author of the study.

The researchers have identified the most important parameters, and have built their model accordingly. In brief, the model takes into account the laws of thermodynamics and the turbulent motion of the droplets. The model corresponds well with earlier numerical computer simulations, and explains their results.

The importance of evaporation

"But we're still a long way from the finish line," continues Professor Mehlig. "Our model is currently able to describe what is happening in one cubic meter of cloud. Say, fifteen years ago it was only one cubic centimeter, so we're making progress."

When policymakers discuss climate change, great importance is attached to IPCC climate models. However, according to the IPCC, the microphysical properties of clouds are among the least understood factors in climate science.

"Moreover, the evaporation of droplets is an important process, not only in the context of atmospheric clouds, but also within the field of infectious medicine. Tiny droplets that are produced when we sneeze can contain virus particles. If these droplets evaporate, the virus particles can remain in the air and infect others."

Professor Mehlig has also co-authored another study that describes how solid particles, such as ice crystals, move within clouds.

"The ice crystals and the water droplets affect each other. But we don't yet know how."

More information: J. Fries et al, Lagrangian Supersaturation Fluctuations at the Cloud Edge, *Physical Review Letters* (2023). DOI: 10.1103/PhysRevLett.131.254201

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